6 Design Procedures

6.1 GENERAL

6.1.1 **Application and Intent.** ~~The design procedures required by this Standard are intended to provide air quality that will satisfy a substantial majority of occupants in spaces that are properly designed, maintained, and operated and that are being used for their intended purpose.~~

The design requirements of this standard may be met by following either the Ventilation Rate Procedure or the Indoor Air Quality procedure.

[Note to reviewers: The above sentence is here for clarity but is actually in Addendum 62i. If Addendum 62i is approved, then its sections 6.1, 6.1.2 and 6.1.3 will be inserted as 6.1.2, 6.1.2.1 and 6.1.2.2. If 62i is not approved, the wording currently in section 4 will be renumbered 6.1.2, section 4 will be deleted, and other sections renumbered according.]

6.2 VENTILATION RATE PROCEDURE

6.2.1 **Scope.** ~~This procedure prescribes the means of determining design Minimum Outdoor Air Intake Rates for ventilation systems.~~

6.2.2 **Minimum Outdoor Air Intake Rate (V_{OAT}).** ~~The~~ The following procedure shall be used to calculate the Minimum Outdoor Air Intake Rate (V_{OAT}) for a system. ~~to ventilation systems shall be sufficient to provide the Design Outdoor Air Rate to the breathing zone (In section 3: change the name of the defined term *occupied zone* to *breathing zone*) of each occupiable space.~~ For the purposes of these calculations, an occupiable space may be considered to be a room or collection of rooms served by the same system of similar occupancy type, occupant density and, supply ventilation rate per unit floor area; or common thermostatic control.

~~The following procedure shall be used to calculate V_{OAT}:~~

~~Exception: While this procedure specifies calculations for all occupiable spaces, the calculations in steps 1, 2, and 3 may be applied to only the occupiable space(s) requiring the highest fraction of outdoor air.~~

Steps 1 and 2 shall be done for all occupiable spaces or for the space(s) requiring the highest fraction of outdoor air.

[Add definition of occupiable space from 62q as note to reviewers.]

.1 **Design Outdoor Air Rate (V_{OA}):** Calculate V_{OA} for the breathing zone ~~of each occupiable space~~ based on the values of R_P and R_B in Table 6.1 and the design occupancy P_{BS} for each space. If the actual occupancy is not known, the default values provided in Table 6.1 shall be used.

$$V_{OA} = R_P P_S + R_B A_S \qquad (6\text{-}1)$$

.2 **Room Air Distribution Effectiveness (E_{RM}):** Determine E_{RM} ~~for each occupiable space~~ using the values in Table 6.2. E_{RM} may also be determined based on measurements of air change effectiveness in accordance with ASHRAE Standard 129.

(In section 3: change the name of the defined term *occupied zone* to *breathing zone*)

.3 **Ventilation System Efficiency (E_V):** Using the values of Voa from Step 1 and Erm from Step 2, dDetermine the value of E_V from Table 6.3.

~~.4 **Occupant Diversity (D_B) (Optional):** To take credit for variations in occupancy within the spaces served by the system, one may calculate D_B. Otherwise, set D_B equal to 1. For single zone systems $D_B = 1$~~

$$D_B = \text{max. population} / \sum_{\text{spaces}} P_S \qquad (6\text{-}2)$$

~~where the sum is applied to all occupiable spaces served by the system.~~

~~.5 **Uncorrected Outdoor Air Intake (V_{OAU}):** Calculate the system V_{OAU}~~

$$V_{OAU} = \sum_{\text{spaces}} R_B A_S + D_B \sum_{\text{spaces}} R_P P_S \qquad (6\text{-}3)$$

~~where the sums are applied to all occupiable spaces.~~

.4 **Average Outdoor Air Rates for System:** Determine the average outdoor air rates R_{Bav} and R_{Pav} per equations

$$R_{Bav} = \Sigma R_B A_S / \Sigma A_S$$

$$R_{Pav} = \Sigma R_P P_S / \Sigma P_S$$

.5 **Uncorrected Outdoor Air Intake Rate (V_{OAU}):** Calculate the system V_{OAU}

$$V_{OAU} = R_{P\,Av.} P_B + R_{B\,Av.} A_B \qquad (6\text{-}3)$$

.6 **Minimum Outdoor Air Intake Rate (V_{OAT}).** Calculate V_{OAT}

$$V_{OAT} = \frac{V_{OAU}}{E_V} \qquad (6\text{-}4)$$

Definition of Variables

(A_B) Total Floor Area: the total occupiable floor area served by the system m^2, (ft^2)

(A_S) Space Floor Area: the net occupiable floor area of the space m^2, (ft^2).

~~(D_B) Occupant Diversity: the maximum expected simultaneous population in the spaces served by the system divided by the sum of the individual space design populations.~~

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(E_{RM}) **Room Air Distribution Effectiveness:** a measure of how effectively the room air distribution uses air supplied to the room to maintain acceptable air quality in the occupied zone.

(E_V) Ventilation System Efficiency: the efficiency with which the system distributes outdoor air to the breathing zone of the space.

(P_B) **Total Population**: the maximum simultaneous number of occupants in the area served by the system.

(P_s) Design Space Population: the largest number of people expected to occupy the space during typical usage.

(R_B) Outdoor air rate required per unit area: the outdoor air rate provided to dilute sensory contaminants that are emitted at a rate that ~~depends on~~ is related more to floor area than to population.

(R_P) Outdoor air rate required per person: the outdoor air rate provided to dilute sensory contaminants that are emitted at a rate that ~~depends on the number of people in a space~~ is related more to population than to floor area.

(V_{OA}) Design Outdoor Air Rate: the design outdoor air rate (V_{OA}) required in the breathing zone of an occupiable space.

(V_{OAU}) Uncorrected Outdoor Air Intake Rate: the outdoor air intake required if the ventilation system efficiency was 100%.

(V_{OAT}) **Minimum Outdoor Air Intake Rate**: the design outdoor air rate at the ventilation system intake.

R_{Bav} is the average R_B for the area served by the system

6.2.3 Exhaust Ventilation. Exhaust air shall be provided in accordance with the requirements in Table 6.4.

6.2.4 Design and Operating Conditions.

Ventilation systems shall be capable of providing the required ventilation rates when the spaces served by the system are occupied, including design load and expected part-load conditions.

~~**6.2.4.1 Ventilation Averaging Period:** For spaces with intermittent provision of supply air and for systems with intermittent closure of the outdoor air intake the volume of outdoor air over any 1 hour period shall be equal to V_{OAT}*60 minutes~~

~~**6.2.4.2 Short Term Occupancy Conditions.** Where short term variations in occupancy occur, the design ventilation rate for a space may be based on the average occupancy over a time period *T*, determined by equation 6-5:~~

6.2.4.2 Short Term Conditions. Where a condition is of short duration , design may be based on the average condition over a time period *T*, determined by equation 6-5:

$$T = \frac{3v}{V_N} \qquad (6\text{-}5)$$

where

v is the volume of the space for which averaging is being applied, m^3 (ft^3).

V_N is the outdoor airflow rate that would result from equation 6-4 if averaging is not considered, L/s (cfm).

.1 **For spaces or buildings with intermittent occupancy:-** The population is averaged over time T calculated above to use in calculating the steady state ventilation required to handle the varying occupancy. Time averaging of occupancy may not be used when demand controls vary the ventilation rate in response to occupancy.

.2 **For spaces with intermittent interruption of supply air,** the volume of outdoor air supplied to the space over time T shall equal V_{OA} * T.

.3 **For systems with intermittent closure of the outdoor air intake,** the volume of outdoor air intake over time T shall equal V_{OAT} * T

6.2.4.3 Dynamic Reset. The system may be designed to reset minimum outdoor air intake and/or minimum space supply flow as operating conditions change. These conditions include but are not limited to:

.1 variations in occupancy where the number of occupants is predictable based on time-of-day or determined using sensors;

.2 variations in the efficiency with which outdoor air is distributed to the occupants under different ventilation system flow rates and temperatures and

~~.3~~ intake of additional outdoor air for free cooling or exhaust make up.

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TABLE 6.1 MINIMUM VENTILATION RATES IN BREATHING ZONE (IP Version)
This table is not valid in isolation, it must be used in conjunction with the accompanying notes

Occupancy Category	People OA Rate R_P cfm/per	Building OA Rate R_B cfm/ft²	Notes	Default Occup. Density #/1000 ft²	OA Rate @ Default rate cfm/per
Correctional Facilities					
Cell	5.0	0.16		25	11.4
Dayroom	5.0	0.06		30	7
Guard stations	5.0	0.06		15	9
Booking/waiting	10	0.06		50	11.2
Educational Facilities					
Daycare (through age 4)	7.0	0.14		25	12.6
Classrooms (ages 5-8)	6.0	0.14		25	11.6
Classrooms (age 9 plus)	6.0	0.10		35	8.9
Lecture Classroom	6.0	0.10		65	7.5
Lecture Hall (fixed seats)	5.0	0.06		150	5.4
Art classroom	6.0	0.10		20	11.0
Science laboratories	6.0	0.10		25	10.0
Wood/metal shop	6.0	0.10		20	11.0
Media Center	6.0	0.14	A	25	11.6
Music/theater/dance	14.0	0.14		35	18.0
Multi-use Assembly	6.0	0.10		100	7.0
Food and Beverage Service					
Restaurant dining rooms	6.0	0.16		70	8.3
Cafeteria / fast food dining	6.0	0.16		100	7.6
Bars, cocktail lounges	6.0	0.16		100	7.6
General					
Conference / meeting	5.0	0.06		50	6.2
Corridors	–	0.06		–	
Storage rooms	–	0.12	B	–	
Hotels, Motels, Resorts, Dormitories					
Bedroom / Living Room	5.0	0.10		10	15.0
Barracks sleeping areas	5.0	0.06		20	8.0
Lobbies/prefunction	7.0	0.06		30	9.0
Multi-purpose assembly	7.0	0.06		120	7.5
Office Buildings					
Individual office	6.0	0.06		15	10.0
Office Building	6.0	0.06		5	18.0
Reception areas	7.0	0.06		30	9.0
Telephone/data entry	7.0	0.06		60	8.0
Main entry lobbies	7.0	0.06		10	13.0
Miscellaneous spaces					
Bank vaults/safe deposit	5.0	0.06		5	17.0
Computer (not printing)	5.0	0.06		4	20.0
Pharmacy (prep. area)	6.0	0.22		10	28.0
Photo studios	5.0	0.10		10	15.0
Shipping/Receiving	–	0.12	B	–	
Transportation waiting	8.0	0.06		100	8.6
Warehouses	–	0.06	B	–	
Public Assembly Spaces					
Auditorium seating area	5.0	0.06		150	5.4
Churches, temples	6.0	0.06		120	6.5
Courtrooms	6.0	0.06		70	6.9
Legislative chambers	6.0	0.06		50	7.2
Libraries	5.0	0.12		10	17.0
Lobbies	7.0	0.06		150	7.4
Museums (Children's)	7.0	0.16		40	11.0
Museums/Galleries	7.0	0.06		40	8.5
Retail					
Sales (except as below)	7.0	0.12		15	15.0
Mall common areas	8.0	0.06		40	9.5
Barber shop	6.0	0.06		25	8.4
Beauty and nail salons	10	0.06		25	12.4
Pet shops (animal areas)	7.0	0.16		10	23.0
Supermarket	7.0	0.06		8	14.5
Coin operated laundries	8.0	0.06		20	11.0
Sports and Entertainment					
Ice Arena (skating area)	–	0.30		–	
Gym, stadium (play area)	–	0.30		30	
Swimming (pool & deck)	–	0.46	C	–	
Disco/dance floors	15	0.06		100	15.6
Health club/aerobics room	24	0.06		40	25.5
Health club/weight rooms	20	0.06		10	26.0
Bowling alley (seating)	10	0.10		40	12.5
Gambling casinos	7.0	0.16		120	8.3
Game arcades	10	0.16		20	18.0
Stages, studios	10	0.06	D	70	10.9

GENERAL NOTES FOR TABLE 6.1

1 **Related Requirements:** The rates in this table are based on all other applicable requirements of this standard being met.
2 **Smoking:** Rates are based on no smoking. Rates for smoking-permitted spaces must be determined using other methods.
3 **Air Density:** Rates are based on air at 1.2 kg_{da}/m^3 (0.075 lb_{da}/ft^3) density. Rates may be adjusted for actual density but such adjustment is not required for compliance with this Standard
4 **Default Occupant Density**: The default occupant density shall be used when actual occupant density is not known.
5 **Default Outdoor Air Rate**: The default outdoor air rate is based on the default occupant density. It must not be used with lower occupant densities.
6 Unlisted Occupancies: If the occupancy category for a proposed space is not listed, the requirements for the listed occupancy category that is most similar in terms of occupant density, activities and building construction shall be used.
7 **Residential facilities, Healthcare facilities and Vehicles:** Rates shall be determined in accordance with Appendix F

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TABLE 6.1 MINIMUM VENTILATION RATES IN BREATHING ZONE (SI Version)
This table is not valid in isolation, it must be used in conjunction with the accompanying notes

Occupancy Category	People OA Rate R_P L/s-per	Building OA Rate R_B L/s-m^2	Notes	Default Occup. Density #/100 m^2	OA Rate @ Default rate L/s-per
Correctional Facilities					
Cell	2.5	0.8		25	5.7
Dayroom	2.5	0.3		30	3.5
Guard stations	2.5	0.3		15	4.5
Booking/waiting	5.0	0.3		50	5.6
Educational Facilities					
Daycare (through age 4)	3.5	0.7		25	6.3
Classrooms (ages 5-8)	3.0	0.7		25	5.8
Classrooms (age 9 plus)	3.0	0.5		35	4.4
Lecture Classroom	3.0	0.5		65	3.8
Lecture Hall (fixed seats)	2.5	0.3		150	2.7
Art classroom	3.0	0.5		20	5.5
Science laboratories	3.0	0.5		25	5.0
Wood/metal shop	3.0	0.5		20	5.5
Media Center	3.0	0.7	A	25	5.8
Music/theater/dance	7.0	0.7		35	9.0
Multi-use Assembly	3.0	0.5		100	3.5
Food and Beverage Service					
Restaurant dining rooms	3.0	0.8		70	4.1
Cafeteria / fast food dining	3.0	0.8		100	3.8
Bars, cocktail lounges	3.0	0.8		100	3.8
General					
Conference / meeting	2.5	0.3		50	3.1
Corridors	–	0.3		–	
Storage rooms	–	0.6	B	–	
Hotels, Motels, Resorts, Dormitories					
Bedroom / Living Room	2.5	0.5		10	7.5
Barracks sleeping areas	2.5	0.3		20	4.0
Lobbies/prefunction	3.5	0.3		30	4.5
Multi-purpose assembly	3.5	0.3		120	3.8
Office Buildings					
Individual office	3.0	0.3		15	5.0
Office building	3.0	0.3		5	9.0
Reception areas	3.5	0.3		30	4.5
Telephone/data entry	3.5	0.3		60	4.0
Main entry lobbies	3.5	0.3		10	6.5
Miscellaneous spaces					
Bank vaults/safe deposit	2.5	0.3		5	8.5
Computer (not printing)	2.5	0.3		4	10.0
Pharmacy (prep. area)	3.0	1.1		10	14.0
Photo studios	2.5	0.5		10	7.5
Shipping/Receiving	–	0.6	B	–	
Transportation waiting	4.0	0.3		100	4.3
Warehouses	–	0.3	B	–	
Public Assembly Spaces					
Auditorium seating area	2.5	0.3		150	2.7
Churches, temples	3.0	0.3		120	3.3
Courtrooms	3.0	0.3		70	3.4
Legislative chambers	3.0	0.3		50	3.6
Libraries	2.5	0.6		10	8.5
Lobbies	3.5	0.3		150	3.7
Museums (Children's)	3.5	0.8		40	5.5
Museums/Galleries	3.5	0.3		40	4.3
Retail					
Sales (except as below)	2.4	0.6		15	6.4
Mall common areas	3.0	0.3		40	3.8
Barber shop	3.0	0.3		25	4.2
Beauty and nail salons	5.0	0.3		25	6.2
Pet shops (animal areas)	3.5	0.8		10	11.5
Supermarket	3.5	0.3		8	7.3
Coin operated laundries	4.0	0.3		20	5.5
Sports and Entertainment					
Ice Arena (skating area)	–	1.5		–	
Gym, stadium (play area)	–	1.5		30	
Swimming (pool & deck)	–	2.3	C	–	
Disco/dance floors	7.5	0.3		100	7.8
Health club/aerobics room	12	0.3		40	12.8
Health club/weight rooms	10	0.3		10	13.0
Bowling alley (seating)	5.0	0.5		40	6.3
Gambling casinos	3.5	0.8		120	4.2
Game arcades	5.0	0.8		20	9.0
Stages, studios	5.0	0.3	D	70	5.4

Item Specific Notes for Table 6.1

A For high school and college libraries, use values shown for Public Spaces – Library
B Rate may not be sufficient when stored materials include those having potentially harmful emissions.
C Rate does not allow for humidity control. Additional ventilation or dehumidification may be required to remove moisture.
D Rate does not include special exhaust for stage effects, e.g., dry ice vapors, smoke.

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Source: https://www.industrydocuments.ucsf.edu/docs/jgjj0001

Table 6.2 Room Air Distribution Effectiveness	
Room Air Distribution	E_{RM}
Ceiling supply of cool air.	1.0
Ceiling supply of warm air and floor return	1.0
Ceiling supply of warm air and ceiling return	0.8
Ceiling supply of warm air and ceiling return if the supply air stream reaches floor level.	1.0
Floor supply of cool air and ceiling return if the supply velocity is high enough to induce mixing of room air. (Most underfloor systems)	1.0
Floor supply of cool air and ceiling return if low velocity displacement ventilation achieves near-laminar flow and thermal stratification.	1.2
Floor supply of warm air and floor return.	1.0
Floor supply of warm air and ceiling return.	0.7
Makeup supply drawn in on the opposite side of the room from the exhaust.	0.8
Makeup supply drawn in near to the exhaust location.	0.5

Notes for Table 6.2

1 "Cool air" is air cooler than space temperature.
2 "Warm air" is air warmer than space temperature
3 "Ceiling" includes any point above the breathing zone
4 "Floor" includes any point below the breathing zone

Table 6.3 Ventilation System Efficiency (E_V) Values		
System Type		E_V
100% Outdoor Air		E_{RM}
Recirculating	$\frac{V_{OA}}{V_P E_{RM}}$	
	≤ 0.25	0.90
	≤ 0.35	0.80
	≤ 0.45	0.70
	≤ 0.55	0.60

1. For systems serving a single occupiable space $E_V = E_{RM}$ may be used.
2. V_P is the supply rate to the space from the system (AHU) at which the design outdoor air intake rate V_{OAT} occurs (Primary AHU). It includes air recirculated by that AHU but not air transferred or recirculated by other means. To take credit for other recirculation paths or if outside the range of this table, use Appendix H to determine E_V.
3. The value of $\frac{V_{OA}}{V_P E_{RM}}$ used to determine E_V shall be the largest value for any zone served by the system.

Table 6.4 Minimum Exhaust Rates					
Occupancy Category	Exhaust Rate cfm/unit	Exhaust Rate cfm/ft²	Notes	Exhaust Rate L/s-unit	Exhaust Rate L/s-m²
Art Classrooms	–	0.70		–	3.5
Auto repair rooms	–	1.50	A	–	7.5
Barber shop	–	0.50		–	2.5
Beauty and nail salons	–	0.60		–	3.0
Cell with toilet	–	1.00		–	5.0
Darkrooms	–	1.00		–	5.0
Arena	–	0.30	B	–	1.5
Kitchen - Commercial	–	0.70		–	3.5
Kitchenettes	–	0.30		–	1.5
Locker rooms	–	0.50		–	2.5
Locker/dressing rooms	–	0.25		–	1.25
Parking garages	–	1.500.75	C	–	7.53.7
Janitor, trash, recycle	–	1.00		–	5.0
Pet shops (animal areas)	–	0.90		–	4.5
Photocopy, printing rooms	–	0.50		–	2.5
Science Lab classrooms	–	1.00		–	5.0
Toilets - public	50/70	–	D	25/35	–
Toilet - private	25/50	–	E	12.5/25	–
Woodwork shop classroom	–	0.50	E	–	2.5

NOTES FOR TABLE 6.4

A Stands where engines are run shall have exhaust systems that directly connect to the engine exhaust and prevent escape of fumes.

B When internal combustion equipment is intended to be used on the playing surface for more than 10 minutes at a time (e.g., bike racing, truck shows), the listed rate shall be collected within 10 feet (both vertically and horizontally) of the play area and exhausted to the outside. Temporary use of internal combustion equipment, such as ice-surfacing machines, is acceptable provided a 5-minute waiting period is allowed before occupants return to the field and the minimum outdoor air ventilation rate is 14,000 cfm.

C Not required if two or more sides comprise walls that are at least 50% open to the outside.

D Rate is per water closet and/or urinal. Provide the higher rate where periods of heavy use are expected to occur, e.g., Theatres, schools, and sports facilities. The lower rate may be used where use is intermittent.

E Rate is for a toilet room intended to be occupied by one person at a time. Provide the higher rate if the occupant switches the system on and off. For continuous ventilation system operation, the lower rate may be used.

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Delete current Appendix F.

[Note to reviewers: This appendix uses a definition of ventilation effectiveness that is not consistent with that used in this addendum. Because the definition is now included in the body of the standard, and in Standard 129 which is referenced, this Appendix is no longer required.]

Replace Appendix F with the following:

This normative appendix is part of this standard and is required for its use.

APPENDIX F

Ventilation Rates for Health Care Facilities, Residential Buildings and Vehicles [Normative]

[Note to reviewers: This appendix contains ventilation requirements for occupancies that are not covered in Table 6.1 but which are covered in Standard 62-1999. These occupancies are expected to be covered by other standards and, once those standards are approved, will be removed from the scope of this standard. At that time this appendix will be deleted.

Since this appendix is simply a relocation of ventilation rates from the normative body of 62-1989 to a normative appendix, it is not a substantive change. The values and wording of this appendix are therefore not subject to public review comments.]

Table F-1*
OUTDOOR AIR REQUIREMENTS FOR VENTILATION
OF HEALTH CARE FACILITIES (Hospitals, Nursing and Convalescent Homes)

Application	Estimated Maximum** Occupancy P/1000 ft^2 or 100 m^2	Outdoor Air Requirements cfm/ person	L/s person	cfm/ft^2	L/s · m^2	Comments
Patient rooms	10	25	13			Special requirements or codes and pressure relationships may determine minimum ventilation rates and filter efficiency. Procedures generating contaminants may require higher rates.
Medical procedure	20	IS	8			
Operating rooms	20	30	15			
Recovery and ICU	20	15	8			
Autopsy rooms				0.50	2.50	
Physical Therapy	20	15	8			Air shall not be recirculated into other spaces

* Table F-1 prescribes supply rates of acceptable outdoor air required for acceptable indoor air quality. These values have been chosen to dilute human bioeffluents and other contaminants with an adequate margin of safety and to account for health variations among people and varied activity levels.

** Net occupiable space

TABLE F-2[a]
OUTDOOR AIR REQUIREMENTS FOR VENTILATION
OF RESIDENTIAL FACILITIES (Private Dwellings, Single, Multiple)

Applications	Outdoor Requirements	Comments
Living areas	0.35 air changes per hour but not less than 15 cfm (7.5 L/s) per person	For calculating the air changes per hour, the volume of the living spaces shall include all areas within the conditioned space. The ventilation is normally satisfied by infiltration and natural ventilation. Dwellings with tight enclosures may require supplemental ventilation supply for fuel-burning appliances, including fireplaces and mechanically exhausted appliances Occupant loading shall be based on the number of bedrooms as follows: first bedroom, two persons; each additional bedroom, one person. Where higher occupant loadings are known they shall be used.
Kitchens [b]	100 cfm (50 L/s) intermittent or 25 cfm (12 L/s) continuous or openable windows	Installed mechanical exhaust capacity[c]. Climatic conditions may affect choice of the ventilation system.[a]
Baths , Toilets [b]	50 cfm (25 L/s) intermittent or 20 cfm (10 L/s) continuous or openable windows	Installed mechanical exhaust capacity[c].
Garages: Separate for each dwelling unit	100 cfm (50 L/s) per car	Normally satisfied by infiltration or natural ventilation
Common for several units	1.5 cfm/ft^2 (7.5 L/s m^2)	See "Enclosed parking garages;" Table 6.1

[a] In using this table, the outdoor air is assumed to be acceptable.
[b] Climatic conditions may affect choice of ventilation option chosen.

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Source: https://www.industrydocuments.ucsf.edu/docs/jgjj0001

[c] The air exhausted from kitchens, bath, and toilet rooms may utilize air supplied through adjacent living areas to compensate for the air exhausted. The air supplied shall meet the requirements of exhaust systems as described in 5.8 and be of sufficient quantities to meet the requirements of this table.

Table F-3*
OUTDOOR AIR REQUIREMENTS FOR VENTILATION OF VEHICLES

Application	Estimated Maximum** Occupancy P/1000 ft² or 100 m²	Outdoor Air Requirements cfm/ person	L/s· person	cfm/ft²	L/s · m²	Comments
Vehicles	150	15	8			Ventilation within vehicles may require special considerations.

* Table F-1 prescribes supply rates of acceptable outdoor air required for acceptable indoor air quality. These values have been chosen to dilute human bioeffluents and other contaminants with an adequate margin of safety and to account for health variations among people and varied activity levels.

** Net occupiable space

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Source: https://www.industrydocuments.ucsf.edu/docs/jgjj0001

Replace Appendix H with the following:

This normative appendix is part of this standard and is required for its use.

APPENDIX H

Multiple Space System Efficiency [Normative]

The efficiency with which a system distributes its outdoor air intake to the occupants may be calculated using the equations in this appendix or the default values in Table 6.3.

Other mass or flow balance equations for multiple space systems may also be used where they are mathematically equivalent to the Appendix H equations or where they more accurately represent a particular system configuration.

Single Source Systems $E_v = 1 + V_{OAU}/V_S - Z$ (H-1)

Equation H1 is suitable for systems where all ventilation is by supply air mixed from outdoor air and recirculated air in a single location. Such systems include Reheat, VAV (single duct), single fan dual duct, and multizone.

General Case $Ev = (A + BX - CZ) / A$ (H-2)

In addition to the systems handled by Equation H-1, Equation H2 is suitable for systems that provide all or part of their ventilation by recirculating air from other spaces without directly mixing it with outdoor air. Such systems include Dual Fan Dual Duct, Fan Powered Mixing Box and transfer fans for conference rooms

Definitions (Border indicates duplicate from text)

A_S Floor area of the space, m^2 (ft^2).

A Fraction of supply air to the space from sources outside the space:- $A = E_P + (1-E_P)\,E_{SR}$

B Fraction of supply air to the space from fully mixed primary air:- $B = E_m\,E_p$

C Fraction of outdoor air to the space from sources outside the space:- $C = 1-(1-E_{RM})(1-E_{SR})(1-E_P)$

D_B Occupant Diversity, the maximum simultaneous population in the area served by the system divided by the sum of space design populations.

E_M A measure of primary air handling unit mixing efficiency. The fraction of primary air to the space which is representative of average, fully mixed, outdoor air and return air for the system rather than unmixed bypassed return air. Uniformity of supply temperature at the first duct branch is a good indication of E_m. E_m may be assumed to be equal to 1.0 except where mixing is known to be poor.

E_P The primary air fraction to the space. $E_p = V_{pc} / V_s$ ($E_p = 1.0$ for single duct and single zone systems).

E_{SR} Only applies where $E_p < 1$. i.e. Primary air to the space is supplemented with secondary recirculation. The fraction of the secondary recirculated air to the space that is representative of average system return air rather than air directly from the space.

E_{RM} Room Air Distribution Effectiveness: A measure of how effectively the room air distribution uses the air supplied to the room to maintain acceptable air quality in the breathing zone. See Table 6.3 for values.

E_V Ventilation System Efficiency: The efficiency with which the system distributes outdoor air to the breathing zone of the space.

R_B Outdoor air required per unit area from Table 6.1.

R_P Outdoor air required per person from Table 6.1.

P_S Design population in the space

V_{OA} Outdoor airflow required to the breathing zone of the space, l/s (cfm)

V_{PT} Primary airflow rate from AHU to all spaces served by system, l/s (cfm)

V_P Supply from Primary AHU to the space, l/s (cfm)

V_{OAU} Uncorrected Outdoor Air Intake, the outdoor air intake required if the ventilation system efficiency was 100%:

$$V_{OAU} = \underset{\text{all spaces}}{\square} R_B A_S + D_B \underset{\text{all spaces}}{\square} R_P P_S$$

$$V_{OAU} = \underset{\text{Av.}}{R_P P_B} + \underset{\text{Av}}{R_B A_B} \qquad \text{(H-3)}$$

V_S Supply airflow to the space (includes primary airflow and locally recirculated airflow), l/s (cfm)

X Ratio of required outdoor air to spaces served by the system to primary air. ($X = V_{OAU}/V_{PT}$)

Z The minimum outdoor air fraction required in air supplied to the space.

$$Z = \frac{V_{OA}}{V_S E_{RM}} \qquad \text{(H-4)}$$

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